PROGRESS REPORT OF THE WESTERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION

JULY 1, 1970

Agricultural Research Service
UNITED STATES
DEPARTMENT OF AGRICULTURE

Prepared by
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Development Division
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U.S. Department of Agriculture
Albany, California 94710

Issued January 1971

Progress Report of the Western Utilization Research and Development Division

July 1, 1970

This report initiates a new way of telling the progress of research at the U.S. Department of Agriculture's research division at Albany, California. We are addressing our report to a wide and general audience:

> To those with a particular need for a summary of new technologies and knowledge of products and processes for agriculture.
>
> To our employees who want to see how individual efforts contribute to our broad goals.
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> To our senior officers, administrators, and advisors who continuously need to review progress in the major areas assigned to this Division.

This is not a ship's log of day-by-day, project-by-project activity. Rather it is a sampling of our efforts. We feature a number of projects where we think our efforts have been particularly fruitful. We give brief accounts of other research of significant interest. And for a number of important problems still unsolved, we explain research approaches that we think will lead to solutions.

Introduction

The Western Utilization Research and Development Division (WU) is one of 15 research divisions of the U.S. Department of Agriculture's Agricultural Research Service (ARS). It has a large headquarters laboratory at Albany, California, a laboratory for citrus research in Pasadena, California, and two small satellite laboratories in Puyallup, Washington and Honolulu, Hawaii. The program of research involves (1) reducing the cost and improving the quality of processed agricultural products, (2) developing products and processes to increase agricultural exports, (3) improving the safety and nutritive quality of our food supply, and (4) preserving environmental quality by reduction in pollution caused by processing agricultural products and disposing of agricultural wastes.

WU shares these responsibilities with four other regional divisions. Commodities appropriate to the regions are assigned to each for investigation, but programs that develop tend to be national in scope and importance. WU is assigned western fruits and vegetables, cereals, forages, wool and mohair, western oilseeds, turkeys, and eggs. Related studies are coordinated among the divisions by a system of documents that describe programs of research, by common supervision in the Office of the Administrator of the ARS, and by frequent meetings and informal discussions among division administrators and scientific staffs.

Subjects for research originate from a number of sources; research is initiated where staff, facilities, and resources exist or can be mobilized. Department policies in response to social and economic needs provide broad objectives of research. Advisory

committees representing various segments of production agriculture and agribusiness have been legally authorized to review ongoing work and recommend modifications or new programs. Committees and spokesmen representing consumer, commodity, and industry interests make their desires known at all administrative levels and to the appropriation committees of Congress. Administrators and supervisors at all levels and, importantly, laboratory scientists and engineers with sophisticated knowledge of products and processes play a major role in the development of specific research programs.

Each research program is documented as to objective, research approach, location, and principal investigator, in a computerized Current Research Information System (CRIS) providing simplified access to information about research activities by subject and research unit. Related programs can be identified wherever they may be located in the Department, and cross-linked in the same system with research at the State Agricultural Experiment Stations.

Annual and terminal reports of progress on research projects are available through CRIS. However, the primary means for disseminating research findings is via scientific and technical publications, patents, and presentations at public meetings. Semi-annual lists of publications and patents are available from each of the five regional divisions engaged in research on processing agricultural commodities.

This report of progress is intended to summarize recent important and interesting aspects of our research. For those interested in, or with a need to know, the complete program of WU research, a printout from CRIS should be sought; for those interested in our publications, the List of Publications and Patents should be requested from this Division's headquarters.

Highlights of Research Progress

Research progress does not pay much attention to calendars. Thus, any progress report covers variable periods of time to tell complete stories. In this section we describe a number of our research projects that have recently produced some important advances by being used in commercial operations for the first time or evaluated for such use.

Reduced Pollution from Potato Processing

A new peeling process reduces pollution load in waste water from potato processing plants. The WURPEEL, or dry caustic peeling process also increases product yield, reduces amount of lye needed, eliminates lye from liquid waste, decreases processing costs, and will greatly reduce the cost of compliance with strict new federal water pollution regulations.

The new process removes peels from potatoes by a dry scrubbing action following a combination of lye and radiant heat treatments. The waste is recovered as a semisolid and can be further treated to make a livestock feed, or disposed of on land.

The conventional potato peeling process used copious amounts of water to flush away the peel after a hot lye treatment. By this action the lye and all soluble material in the peel became part of the plant's liquid waste. Treatment to remove this soluble waste from the water is costly, but necessary to comply with anti-pollution laws.

With the new method, food yields are increased by more than 5%, lye usage reduced by 50%, and the organic

material that must be otherwise removed from waste water is reduced by 75%, with no sodium from the lye entering the water wastes.

Laboratory studies were made on equipment operating at about 600 pounds per hour. Then a pilot operation, tenfold larger, was tested alongside conventional commercial peeling operations in Aberdeen, Idaho. The Engineering Committee of the Idaho Potato Processors and Magnuson Engineers, Inc.* participated in the tests at a plant owned and operated by the Idaho Potato Growers Co-op.

Encouraging results at this scale led to the installation in Grand Forks, North Dakota, of a commercial operation rated at 60,000 pounds per hour. Supported in part by a demonstration grant of $290,000 from the Federal Water Quality Administration of the Department of Interior, Western Potato Service Company operated this new system for six weeks at the close of the 1969 potato harvest. Operations will continue with the 1970 harvest and data and description of the operation will become available to industry to guide further adoption by private action.

Results from laboratory, pilot plant, and commercial demonstrations (not yet completed) have been sufficiently encouraging so that other large-scale commercial operations have been initiated at private cost.

The dry scrubbing principle of WURPEEL is applicable to peeling other vegetables and fruits, but

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* Mention of commercial companies or products does not imply recommendation or endorsement by the U.S. Department of Agriculture over others not mentioned.

modification of the scrubbing equipment is required in some cases. Sweet potatoes and other root vegetables were peeled satisfactorily in preliminary studies. Peeling of apricots and peaches is being tested. This pollution-reducing treatment also appears promising for apples and pears. For soft-fleshed fruits, radiant heat is not required but new scrubbing equipment is being devised.

Field Processing of Tomatoes to Reduce Waste and Pollution

Preprocessing tomatoes at the point of harvest can reduce waste by avoiding fruit deterioration that occurs during long hauls, and from delays in moving the fruit from the fields to the processing plant. Also, liquid and solid wastes can be more easily disposed of at field locations than at processing plants that frequently are located in urban areas.

Field preprocessing can be applied to tomatoes used for juice or concentrated juice products such as catsup or tomato paste. Over 80% of the U.S. 5 million ton tomato crop grown for processing is made into such products.

In a field operation, tomatoes are cleaned, crushed, and made into juice at a specially designed station in the production area. Skins, seeds, spoiled tomatoes, leaves, stems, and other solid wastes are disposed of by spreading on farm lands and wash water is returned to the land by irrigation. This system minimizes the pollution problem.

During hauls of 100 miles or more, which are not uncommon in California, from 10 to 20% of the harvested fruit may spoil. By preprocessing in the field, most of this fruit is saved as food product, and does

not add to the waste disposal problem at the processing plant. As much as 400,000 tons of tomato waste could be avoided.

An important variation of field preprocessing is mixing a low level of acid with the crushed heated tomatoes. The treatment increases the yield and consistency of juice. Also, it should help control spoilage and quality loss during field processing and transportation of juice to the plant for further processing because spoilage is reduced by acidity of products. The acid treatment assures the consistency, quality and stability of the juice until it can be heat sterilized or converted into concentrated products. The acid can be neutralized during preprocessing or at the processing plant, providing the net effect of a small addition of common salt to the product.

Forage Process for Better Feeds

The traditional field drying of alfalfa and other forages is inefficient--feed value is lost as the cut hay is exposed during drying on the ground. Newer methods that save nutrients of forage include field cubing or artificial dehydrating and pelleting. Nutrients in dehydrated alfalfa can be further protected by use of antioxidants, or by inert gas storage.

Earlier developments include a process for separating the leaf from the stem portions of dehydrated alfalfa. This process provides a low-fiber high-protein leaf meal suitable for chicken and swine feeds, and a stem fraction, valuable for cattle feed.

Most recently, a separation process on fresh, undried alfalfa has been extended to commercial operations by the Batley-Jans Company. They are producing a fiber

free feed fraction that contains high levels of protein and xanthophylls which give desirable pigmentation to poultry products. This material, in a dry form, is well suited for export to Japan and Europe for their growing poultry production operations.

The PRO-XAN process consists of squeezing juice from freshly cut alfalfa--sugarcane rolls are used in the commercial development to remove about 30% of newly cut alfalfa as a fiber-free juice. This juice is heat-coagulated to give a protein concentrate that contains most of the valuable pigments. The pressed alfalfa is dehydrated with improved economy because of the removal of juice.

Research is underway to find the important feed values retained by the brown juice left after the protein and pigment are removed by coagulation. The juice can be concentrated to a molasses-like material to provide added energy and other biological values to feed.

From the crude protein coagulate, a bland, pigment-free, high-quality protein suitable for food use can be refined on a laboratory scale. The feasibility of food protein recovery in commercial operation is being investigated.

New Wheat Products To Improve Food Supply

An important mission of the U.S. Department of Agriculture is guaranteeing an adequate food supply at home and, through AID programs, overseas in the developing countries of the world.

Wheat Protein Concentrate is recoverable from by-products (brans or shorts) left over from flour milling. Reducing the moisture and remilling these mill fractions can provide a source of food-grade flour that is high in protein, low in fiber, and

relatively high in lysine, a nutrient essential for good food value of wheat and wheat products.

The 5 million tons of mill byproducts normally used for animal feeds can be reprocessed to yield one million tons of high-protein food--Wheat Protein Concentrate, a product with far greater value.

More than 4 million pounds of Wheat Protein Concentrate were purchased in 1969 for AID programs as an ingredient in a Wheat-Soy Blend used in infant and child feeding programs.

The protein in wheat and wheat products can be strengthened nutritionally by adding lysine. Extensive tests are underway in India and Tunisia to provide data on the optimum levels of lysine fortification. Lysine is infused into wheat kernels and bulgur (a precooked, partially debranned wheat of historic use in the Near East and now used in U.S. food aid programs). Rapid, reliable analytical procedures were developed to determine the quantity of lysine in processed wheat. They can be used in manufacturing control and in establishing conformity with purchase specifications, especially for lysine-fortified wheat bulgur.

A modern automated process for bulgur manufacture had been developed previously and studies on the nutrients and stability of bulgur were completed.

Although bulgur is widely used and accepted in the Near East, its acceptance for food use in developing nations of south Asia has been limited because of high bran content and brownish color, particularly when made from red wheats. A number of years ago we developed a chemical debranning method to produce a low-fiber, whole or cracked kernel, precooked wheat

product (WURLD wheat) that might replace bulgur in these important markets. Initially, 10 tons of this product were distributed through Church World Services, particularly in Hong Kong and the Philippines, to determine acceptability. Recently 15 tons of WURLD wheat were prepared for further market tests, principally in Indonesia but also in India, Korea, Taiwan, Vietnam, Brazil, and again in Hong Kong. Commercial interest in WURLD wheat is continuing.

Preventing Cross Contamination in Egg Pasteurizers

Safety of preserved egg products is assured by pasteurization to eliminate salmonella food poisoning bacteria. Efficient operation of egg pasteurizers introduces cold unpasteurized egg into a heat exchanger opposite the pasteurized product that must be cooled. Heat energy is thus saved and cooling requirements reduced. However, in such units, thin plates separate the pasteurized and unpasteurized material and minute imperfections can allow a recontamination of the pasteurized product. A reliable and efficient procedure to test such equipment for leaks has been developed and demonstrated in commercial processing plants.

Minimum heat treatment is desirable in pasteurizing eggs because important functional properties may be lost during the heat treatment. The minimum condition that destroys salmonellae in liquid whole egg is heating to 140° F. for 3-1/2 minutes. Studies showed that equivalent safety for other egg products requires different conditions. For example, yolk pasteurization requires 142° F. for 3-1/2 minutes for the same degree of safety from salmonella; sugared or salted yolk, 146° F. Application of such data has made it possible to assure for all egg products the same high level of safety established for whole egg.

To further assure safety, an enzyme test was devised that can be used to determine if egg products have been maintained at pasteurization temperature for the proper length of time. The enzyme β-N-acetylglucosaminidase, which is present in egg white, was found to be inactivated in the temperature range 138° to 142° F. so that the amount of enzyme activity remaining is a measure of the heat treatment applied.

Converting Citrus Byproducts to Noncaloric Sweeteners

Certain very bitter compounds (flavanoids) in citrus fruit can be chemically changed to extremely sweet compounds called dihydrochalcones (DHC). As nonsugar sweeteners, they could be useful for diabetics in low-calorie beverages, toothpastes, pharmaceuticals, and related products, and to make diets more attractive for obese persons. Until recently the growing market needs for such products seemed adequately met by saccharin and cyclamates.

In October 1969, a ban on the use of cyclamates in food was issued by the Food and Drug Administration and from that moment interest in the DHC sweeteners has flourished.

A number of flavanoid compounds exist in citrus fruits, particularly concentrated in the peel. At one time they were thought to have therapeutic effects that would make citrus extremely desirable in the diet to prevent illness. However, the Food and Drug Administration has concluded that they have no easily demonstrated biological effects but are broken down and excreted by human metabolism without harm or benefit. This finding may not have benefitted the citrus industry but is a good omen for the possible development of new nontoxic, noncaloric sweeteners. The chemical change that makes bitter flavanoids sweet is

a fairly minor one and, on theoretical grounds, would not be expected to result in harmful effects to humans using DHC as a food additive. Nevertheless, extensive testing must be conducted to provide the assurance required by the Food and Drug Administration before the new compounds will be acceptable as food ingredients.

Preliminary tests indicate that dihydrochalcones are probably safe. The more extensive prolonged tests, which still must be made before gaining approval for use, require several hundred pounds of each compound to be fed to test animals over at least a two-year period. Such supplies are being accumulated, and tests are continuing to provide the required assurance of safety for at least the two most promising DHC sweeteners.

From the types of citrus produced in the United States, grapefruit peel (which contains naringin) and orange peel (which contains hesperidin) would be the logical sources of material to be used in manufacturing DHC. About a million tons of grapefruit are processed per year and about one-third of that weight is waste peel containing about 2000 tons of naringin, which could be converted to DHC. Two types of DHC having somewhat different characteristics and levels of sweetness could be made from naringin. Another type can be made from hesperidin. About 1500 tons of naringin DHC or 600 tons of neohesperidin DHC could be made from 2000 tons of naringin. Neohesperidin DHC is about 50 times as sweet as cyclamates, so that 600 tons would be more than ample to provide the degree of sweetness to replace the 10,000 tons per year of cyclamates which were removed from the U.S. market alone. In addition, exports of raw citrus peel or finished product could be anticipated in order to replace the cyclamate which has been taken off the market in many foreign countries including Japan.

The Mystique of San Francisco Sour Dough French Bread

A unique type of sour dough French bread has been savoured in the San Francisco Bay Area for more than 100 years. It not only is quite popular locally, representing about 15% of the bread consumed, but is also sold to tourists in substantial quantities and shipped to specialty markets around the world. French or hearth breads are produced elsewhere in the United States of course, but are quite dissimilar from the local San Francisco product.

Baking operations involve frequent transfers of the sour dough sponge (which carries the active ferment), and a large portion of sponge is needed in the dough mix. Long proof time and slow baking are required. Rigid market distribution schedules must be maintained so that delivery is made within a few hours of baking, because this type of bread stales very rapidly.

In contrast to sour dough French bread, the usual popular breads sold throughout the nation are made by quick, automated processes and are formulated to resist staling for a few days to allow for distribution to markets from large central bakeries. Many people feel that these soft breads lack important texture and flavor characteristics; however, they have become popular with bakers because efficiency in baking and distribution minimize the cost and with consumers because of low cost and resistance to staling. However, both market and trade practices for the sour dough French bread have built up slowly over several decades in the San Francisco area and such practices cannot be easily adopted in other areas of the nation.

It now seems possible to achieve simplification and cost reduction for the baking methods used for sour

dough French bread. Also, it should be possible to confer upon the soft breads made by automated baking methods, some of the flavor benefits of the sour dough fermentation. First, however, we must understand this fermentation that can convert simple mixtures of flour, salt and water into a delightful food.

The microbiology of this sour dough is an interesting dovetailing of an unusual yeast and a heretofore undescribed bacterium. The yeast tolerates a fairly high acid concentration but cannot utilize the maltose that is formed by breakdown of wheat starch. The bacterium is a most unusual acid-forming type that thrives on maltose and requires the carbon dioxide produced by the yeast. Apparently it has not been observed or classified by generations of microbiologists who have systematically sought to identify all readily available life forms in this size range. Efforts to precisely classify this bacterium are underway.

With the knowledge already obtained one can foresee new processes that will (1) reduce costs of sour dough bread manufacture, (2) provide a pure culture, stable starter for use in this bread manufacture, and (3) utilize this culture to improve the flavor of many types of bread that may be made by automated equipment and that are formulated to resist staling.

Quick-Cooking Frozen Dry Beans

Commercial processing and extensive market trials are underway with a new convenience product made from dry beans.

One reason that markets for dry beans have declined is the tedious preparation and advance planning

necessary for their use. Not only is much time consumed, but generally the decision for use must be made the day before they are served. Canned beans are a true convenience product; their use avoids such kitchen drudgery and advance planning. However, canned beans do not lend themselves well to recipe variation thought desirable by many housewives. Some canned beans, such as large Lima beans, tend to break up and lose texture and flavor in the heat sterilization process required in canning.

A new frozen product uses dry beans that are presoaked in solutions of safe, acceptable salts; this reduces their cooking time. The frozen product may be cooked from the frozen state in 15 or 20 minutes, about the time required for many frozen vegetables. The product is adaptable for use in traditional recipes, but the overnight soaking of dry beans is eliminated.

The Oxnard Frozen Food Co-op has produced sizable quantities of several varieties of frozen quick-cooking dry beans; these are being test marketed under the China Doll trade name in the southeastern part of the United States. After six months of testing, results look quite promising for increasing the market for dry beans in this form. One large food chain and a marketing co-op are developing plans for additional market testing in other areas of the country.

Other Research Progress

In a division the size of WU (about 200 principal scientists and their support staff) many different projects are in midstream at any moment. In this section we describe a number of such projects. Some have uncovered important scientific knowledge that can be applied to critical problems, some have moved far enough to assure important advances but require additional laboratory development before full-scale commercial adoption and consumer benefits can result, and others have led to successful commercialization but remain in the experimental program for further refinements and applications in other commodity areas.

Digestibility of Coarsely Ground Whole Wheat and Wheat Fractions

The aleurone layer of cells lies just under the bran on the surface of the wheat kernel and contains a higher concentration of important nutrients than the rest of the kernel. When wheat mill fractions are fed to chicks, the aleurone cells do not release all of their nutrients because the strong cell walls prevent access by digestive systems. Steam pelleting of bran causes a significant increase in feed efficiency by releasing the aleurone cell contents. The fact that physical disruption of the aleurone cells is required to make the nutrients available casts some doubt on the alleged superior food value of coarse ground whole wheat flours compared with more refined flours that are enriched by adding back nutrients.

Frozen Eggs for Scrambling

Freezing and storing frozen eggs causes changes in the viscosity and appearance of liquid whole egg that

reduce its suitability for making scrambled eggs. Several ways of combining small, acceptable amounts of salt and sugar with the liquid before freezing, and homogenization bring about lower viscosity and smooth appearance that are desired by institutional and restaurant users who can save money by using liquid instead of shell eggs.

Improving Feeds by Computer Programs

Laboratory analyses and animal feeding tests indicate nutritional values of new and improved alfalfa, safflower, castor, wheat, and wheat mill feed products. Economic value in formulating mixed feed for poultry, swine, and cattle can be predicted for the new products by using a telephonic, time-sharing computer service. This system, developed in cooperation with the Economic Research Service, enables us to verify the value of our product developments for the feed industry.

Color and Flavor Control in High Oil-Yielding Varieties of Safflower

Thin-hulled, brown striped safflower varieties can be used by plant breeders to develop new varieties that will improve oil yields. Thinner hulls on safflower seed assure lower fiber and higher protein in the oil press cake--critical factors in feed use. However, the brown pigment in the hull and other seed constituents give rise to dark colors and off flavors and odors that are undesirable in a vegetable oil for food use. We have identified several of the compounds which cause off color and flavor and devised means to prevent their deleterious effects on edible oils. Thus plant breeders can feel free to continue use of valuable parent varieties without concern for color and odor factors that typify certain varieties.

Bitterness in Citrus Products

An intensely bitter component (limonin) develops in juice from navel oranges after they have been pressed and limits the utility of this orange variety for processing. A rapid, specific and sensitive method for determining this component is used in raw material evaluation and quality control by several western citrus juice companies. The delayed development of limonin was explained by tracing it to its chemical origin and the enzyme-catalyzed reactions that lead to its formation. The limonin precursors also exist in lemon and grapefruit, sometimes in sufficient quantity to produce an undesirable bitterness in their juice products. Limonin is thus revealed as a cause for intermittent occurrence of bitterness in grapefruit and lemon products as well as navel orange juice. The factors that influence the natural formation and disappearance of the nonbitter limonin precursor are still under investigation to provide a basis for alleviating undue bitterness in some citrus products.

Tropical Fruit Purees

Maximum utilization of Hawaiian-grown tropical fruits in the continental United States is limited by the cost of transportation, the losses in quality when ripe fruit must be shipped and marketed over a period of several days, and the fumigation that is required to prevent transport of harmful insects to the Continent. Fumigation adds cost and hurts quality. Refrigerated purees are useful for remanufacture into fruit juice combinations and other preserved products with minimum shipping costs and no problem of insect infestation. Guava puree was concentrated and stored under refrigeration with small additions of acceptable chemical preservatives, thus providing tree-ripe fruit that can be stored and shipped for remanufacture in the continental United States.

Durable Press Garments with Wool Blends

Commercial treatments that make cotton fabrics durable press do not accomplish the same thing with wool. A new chemical finish (an aziridine resin) provides durable press to wool fabrics and is compatible with the cotton finish so that wool-cotton or wool-cellulosic blend textiles can be treated in one solvent bath to provide durable press quality. The new process was adapted for commercial trials with the Koratron Company. It is less expensive and simpler to apply than earlier multiple-step treatments for durable press wool blend fabrics.

Mohair Processing by Corona Treatment

Because mohair is slippery, fiber assemblies don't hold together in the woolen processing system. Treatment of mohair fibers in a corona (an electrical discharge field at atmospheric pressure) increases the surface friction of fibers without sacrificing desirable luster. The increased surface friction permits processing of mohair in the woolen carding machine. Also it can be spun into yarn at higher speeds (hence lower costs) and yields yarns of greater strength.

Machine Washability Applied to Wool Knits

Knit wool garments can be made shrink-resistant to repeated machine washing and drying. Sweaters retain shape and appearance in wear without excessive pilling, fuzzing, or distortion of knitted structure. The shrink-resist process is combined with normal wet finishing procedures in an automated laundry washer-extractor that sequentially treats a batch of garments to remove sizing, agitates them to give desired

body to garments, applies first one and then another chemical (an isocyanate and a diamine) which react on fiber surfaces to create a chemically-anchored ultra-thin resin film that protects the garment from shrinking, and finally washes and tumble dries the garments to yield fully relaxed knit structures.

Grease and Stain Repellent Compounds for Finishing Wool

Synthetic fluorine-containing compounds that form polymers were synthesized for application to wool textiles to impart grease and soil resistance. The raw materials and synthetic pathways are such that these compounds should be much less expensive than the currently available commercial products. Two interesting sidelights to this work involve the possible use of the new fluoropolymers as safe defoliants and herbicides. When sprayed on leaves, the polymers gradually release defoliant or herbicidal breakdown products and degrade eventually to nontoxic residues. The use of such degradable compounds would avoid the possibility of pollution of soil from unwanted accumulation of toxic residues. A second unanticipated development of this new type of compound is the application of fluoroalkylsilane to glass to make cleaning easier. Decreased light transmission through glass in commercial greenhouses causes a serious loss of production. Detergent cleaning of the glass is ineffective, but the application of new fluoropolymers can provide ease of cleaning that will materially reduce operating costs.

Problems Still Seeking Solutions

"Science can permit us to refashion ourselves and our world." Philip Handler, 1970.

Problems of our society and opportunities for economic advance exist, and are appropriate subjects for continuing research.

Pollution Abatement and Environmental Control

The advance of civilization, especially the protective measures that have fostered population increase and the improved technologies that provide affluence and life comforts, has threatened the world with pollution. We now need to use more of our research resources to develop methods for recycling waste materials back to use, or to minimize or avoid pollution entirely by modifying processes that now produce waste.

Conversion of straws and other agricultural waste to feeds. About half a billion tons of unused agricultural wastes are disposed of annually. For years, in the western and midwestern areas of this country, cereal and other straws have been and still are disposed of by burning. Smoke contamination of the atmosphere is so great at burning time, however, that many local and state governments have either banned or plan to ban this practice. Development of non-polluting procedures for straw disposal is absolutely necessary, and value recovery is desirable. Conversion of straws into energy-rich cattle feed appears promising and already has been shown feasible on a laboratory scale. Economic studies indicate the value of these products is great enough to justify intensive

effort to develop and demonstrate practical commercial processes for waste conversion through animal feeding trials. Possible processes include application of high pressure steam and chemical or microbial treatments that will increase greatly the feed values of typical straws.

Scouring wool. Raw wool must be cleaned of natural grease and contaminating substances before it can be processed into yarns and textiles. Typically wool is scoured in water from which lanolin may, or may not, be recovered. In either case large volumes of polluting liquid wastes are left for disposal. Improved methods that avoid or substantially reduce the amount of water used in wool scouring are being investigated to reduce or eliminate these liquid wastes.

Nutrition and Safety of Food Supply

> Our population movement from agriculture to industry removed consumers from an easy familiarity with, and simplicity of, their food supply. The typical consumer knows almost nothing about the source and preservation of his foods and very little about how they have been cooked and what nourishment they provide. Instead of the protection inherent in traditional and conservative diets developed over the generations, new foods, new preservation practices, and new cooking methods dominate our diets. We depend upon processing companies to substitute food of adequate nutritive content for the traditional foods we abandoned. The general good health of the population seems evidence of their success and good will, yet more must be known of enrichment and protective measures so that our meals remain nutritious and safe as well as enjoyable repasts.

Iron fortification of cereal products. Recent surveys have found mineral deficiencies, particularly iron and calcium, in segments of the United States population. In the past, correction of dietary deficiencies has been achieved by appropriate additions to certain foods. Goiter was largely eliminated by adding iodine to our salt. Rickets almost disappeared because of the vitamin D fortification of milk. Critical natural nutrients that are removed in milling wheat for white flour are added back to flour for use in households or in commercial bakeries. A possible solution to the iron deficiency is to increase bread fortification and require fortification of other cereal products (e.g., breakfast cereals and baked goods) with some form of iron that can be easily assimilated by persons eating such products. Answers are being sought to the questions: what form of iron and how much can be added to various products without reducing their acceptability? to what extent can a human assimilate such iron additions? how does the iron addition affect the keeping quality of the products?

New antimicrobial compounds. Chemicals long have been used to prevent food spoilage. A few examples are salt, fumes of burning sulfur, and the smoke from wood fires. Some compounds must be used in fairly high concentrations to be effective and, in high concentrations, their safety sometimes is suspect. To obtain safer preservatives, a systematic search is being made to determine what components of plants or animals are effective as defense mechanisms, preventing bacterial infection. Natural phenolic compounds are currently under investigation. Already one such compound has been isolated from plant material and found to be a more powerful preservative than several commercial synthetic fungicides.

Detoxifying harmful natural components of foods. Many foods contain undesirable compounds which can occur at deleterious levels. An example is solanine, an alkaloid which naturally occurs only in harmless concentrations in potatoes, but occasionally it may increase to toxic levels, for example, when stored potatoes turn green from exposure to light. Other compounds exist in many common foods at levels that would not cause sickness but which, in the long run, may be harmful. Many of these harmful compounds can be rendered inactive if they are attacked by other active biological compounds (enzymes) to cause a chemical conversion. Investigations are underway to determine which enzymes are effective in degrading specific undesirable cyclic organic compounds to make food safer.

Sanitary processing of poultry. Salmonella infection is an important cause of illness in the United States and contaminated poultry and eggs are major sources of infection. Poultry meat products can provide a source of such infection, even though thorough cooking of poultry meat destroys the harmful microbes and renders cooked meat completely safe. Lack of sanitation and skill in the kitchen sometimes leads to contamination of cooked poultry with the organisms that entered the kitchen on uncooked birds. Investigations are in progress to reduce the opportunity for contamination of poultry while it is being defeathered and dressed and to remove contamination if, inadvertently, it occurs.

New Products to Increase Foreign Markets

Agricultural production in the United States can outstrip consumption, so continuing foreign trade is required to avoid serious economic disruption. While we continue to

increase our imports of manufactured goods, the exports of agricultural products loom more and more important to maintain a balance of payments in international trade. Markets for agricultural products are fiercely competitive both as to price and quality. With generally higher labor costs in the United States than in other nations, price competition is to our disadvantage so we must depend on the quality of our agricultural products. Research is aimed at developing products of higher quality and better stability to command attention in these markets.

Improving the quality of wheat foods. The export of cereal grains helps our balance of trade by direct sales for hard currencies, and provides food for hungry people through concessional sales to developing nations. Research to preserve and expand these export markets involves maintaining or improving the quality of our products. For example, in Japan, much of the increasing demand for wheat is for noodle and cake manufacture. For these outlets, sprout-damaged and strong gluten soft wheats do not produce good products. Research is underway to develop means for overcoming the bad effects of sprout-damaged wheat in the manufacture of products of this type. Research is conducted to find new and improved wheat products to provide the functional and nutritional requirements that will maintain overseas markets.

Better fruit products for export. Dried fruits have been important in export markets in western Europe and Japan but the use of stabilizing additives has created barriers to these markets. Examples are: sulfur dioxide for golden raisins and cut fruits, and sorbic acid or sorbates to prevent molds on high-moisture

dried fruits. Without the use of such additives, spoilage and quality deterioration occur. We must continue the search for preservatives that are harmless by anyone's standards.

Improving Efficiency in Our Food Supply

> The farm value of foods used in the United States totals about $20 billion. Transporting, packing, processing, distributing, and selling foods adds another $80 billion to the price consumers pay for their food. Research that can substantially reduce the processing and marketing cost of foods clearly provides a principal benefit to all consumers as well as to the industries involved in the market chain.

Processing mechanically harvested fruits and vegetables. Efficient production of raw material for fruit and vegetable processing requires rapid advances in mechanical harvesting and field handling. The quality and kind of product resulting from mechanized agriculture are different from hand harvested crops. New varieties must be introduced. The maturity selection of the experienced hand picker is lost with mechanical methods. Trash content is higher, and bruising and breaking of pieces of vegetables occur more frequently. Research is conducted to make sure that new varieties have appropriate processing characteristics. New processes and products must be developed to utilize the under-mature and over-mature material that is sorted from the prime quality product that goes into conventional processes.

Better foods using egg products. Price stability of the egg market is maintained partly by conversion of

surpluses to stable products for later sale. Frozen and dehydrated forms of eggs reduce costs for institutional users. They also provide eggs in a more convenient form for certain uses. However, processing to convert eggs into more stable and convenient forms frequently damages the functional characteristics needed for certain food uses (e.g., the foaming properties for meringues and souffles, the fat emulsifying qualities for mayonnaise, etc.). Research is continuing to identify functional properties of individual protein components of egg to define the effects of processing on the specific components in order to guide development of better processing methods yielding improved products.

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